*Pediatr Neonatol* 2010;51(2):103–111

ORIGINAL ARTICLE

# New-onset Seizures in Pediatric Emergency

Chun-Yu Chen[1], Yu-Jun Chang[2], Han-Ping Wu[3,4*]

[1]*Division of Pediatric Emergency Medicine, Department of Pediatrics, Changhua Christian Hospital, Changhua, Taiwan*
[2]*Laboratory of Epidemiology and Biostatistics, Changhua Christian Hospital, Changhua, Taiwan*
[3]*Department of Pediatrics, Buddhist Tzu Chi General Hospital Taichung Branch, Taichung, Taiwan*
[4]*Institute of Clinical Medicine, National Yang-Ming University, Taipei, Taiwan*

Received: Nov 17, 2008
Revised: Jun 17, 2009
Accepted: Jul 20, 2009

**KEY WORDS:**
children;
emergency department;
first seizure

**Background:** Seizures account for 1% of all pediatric emergency department (ED) visits. The aim of this study was to analyze the clinical spectrum and prevalence rates of various etiologies in children with a first attack of acute seizure disorder in the ED.
**Methods:** We evaluated 319 children who presented to the ED at the Changhua Children's Hospital with a first attack of seizure disorder from 2005 to 2007. Variables including demographics, clinical presentations, laboratory tests, brain imaging studies, electroencephalography, diagnoses and hospital course were compared between patients with seizures and fever, and patients with seizures without fever. These variables were also compared between patients with simple and complex febrile seizures and among different age groups.
**Results:** Among these 319 patients, 218 (68%) presented with seizures and fever and 299 (94%) children were younger than 6 years of age. Generalized tonic-clonic seizures were the most common type (71.2%). Febrile seizures (62.1%) were the main etiology of the first seizure ($p<0.001$). Seizures caused by severe electrolyte imbalance or hypoglycemia were noted in three patients. Abnormal brain images were noted in 16 (26%) of 61 patients, most (12/16, 75%) of whom had abnormal histories and physical or neurologic examinations.
**Conclusion:** Primary care pediatricians should evaluate children presenting to the ED with a first seizure for age, coexistence of fever, seizure type, associated symptoms and history of head injury. We suggest that electrolytes, blood sugar and emergent brain imaging studies should be arranged based on detailed history-taking and thorough physical examinations, but should not be performed routinely.

## 1. Introduction

Seizures are the most common and frightening neurologic disorder of childhood. They occur in approximately 4–10% of children and account for 1% of all emergency department (ED) visits.[1] Children under 3 years of age have the highest incidence of seizures, and this incidence decreases with increasing age.[2] There are many possible etiologies of a first attack of seizure in children, including infection, neurologic/developmental causes, traumatic head injury and metabolic disturbances.[3] In some studies, febrile

*Corresponding author. Department of Pediatrics, Buddhist Tzu Chi General Hospital, Taichung Branch, 66 Fong Sing Road, Section 1, Tanzih, Taichung 42743, Taiwan.
E-mail: arthur1226@gmail.com

seizures were reported to be the most common type seen in the pediatric population in the out-of-hospital and ED settings, and to account for the majority of seizures seen in children younger than 5 years of age.[4,5] To our knowledge, febrile seizures can be classified as simple or complex types.[6]

The reported incidence rates for non-febrile seizures in children range from 89 to 134 per 100,000 person-years.[7] It is not always immediately clear which laboratory and imaging examinations should be performed when children present to the ED with a non-febrile seizures. Children who present to the ED with new onset of non-febrile seizure are often evaluated using cranial computed tomography (CT); however, according to recent investigations, brain CT scans are not routinely arranged for these patients.[8] Primary care physicians in the ED have to face the challenge of initial management of patients with seizures and further evaluation of the indications for brain imaging studies, especially in patients who present with a first attack of seizure. After stabilizing the patient in the ED, the primary challenge for the ED physician is to decide whether to admit or discharge the patient. Misdiagnosis carries the potential risk of legal problems, can cause family anxiety, lead to excessive hospital stay, and possibly result in life-threatening events. In this retrospective study, we therefore analyzed the prevalence of various etiologies and the clinical spectrum of seizure disorders in children who presented to the ED with a first attack of acute seizure disorder.

## 2. Materials and Methods

### 2.1. Patient population

We reviewed the hospital records of 433 patients aged younger than 18 years who presented to the pediatric ED at the Changhua Children's Hospital, Changhua, Taiwan with seizure disorder from 2005 to 2007. Among these 433 patients, recurrent seizure disorder was diagnosed in 114 patients. These children were excluded from the study. Therefore, 319 pediatric patients with a first attack of seizure disorder were included.

### 2.2. Methods

The following information was obtained from the medical records of each patient: age (range from 8 days to 18 years, median age: 2 years), sex, type of seizure, associated symptoms (fever, cough, rhinorrhea, vomiting, diarrhea and headache), family history of seizure or epilepsy, developmental history, laboratory test results [white blood count, C-reactive protein, stool rotavirus antigen test, serum electrolytes, blood sugar and cerebrospinal fluid (CSF) analysis], neuroimaging findings [cranial magnetic resonance imaging (MRI) or head CT scan], electroencephalography (EEG) findings, duration of hospital stay, final diagnosis, anticonvulsants given in the ED, admission to intensive care unit (ICU), general ward and pediatric observation unit. Patients were divided into two groups based on whether the seizure was with or without fever: Group 1 comprised patients with an auricular temperature greater than or equal to 38°C, and Group 2 comprised patients with an auricular temperature less than 38°C. All data for auricular temperature in our study were obtained using a Braun ThermoScan, IRT 4520 (Braun GmbH, Kronberg, Germany).

Seizure type classification, including generalized tonic-clonic (GTC), generalized tonic, and partial was based on the Commission on Epidemiology and Prognosis, 1993 International League Against Epilepsy.[9] Status epilepticus was defined as, "a single epileptic seizure of more than 30 minutes or a series of epileptic seizures during which function is not regained between octal events in a period more than 30 minutes long".[9]

Febrile seizure was defined by the 1993 International League Against Epilepsy as, "an epileptic seizure occurring in childhood after 1 month of age, associated with febrile illness not caused by an infection of the central nervous system (CNS), without previous neonatal seizure or previous unprovoked seizure, and not meeting criteria for other acute symptomatic seizure."[9] In addition, febrile seizures were classified as simple febrile seizures or complex febrile seizures. A simple febrile seizure lasts less than 15 minutes, is initially generalized in nature, and occurs once during a 24-hour period. In contrast, a complex febrile seizure lasts more than 15 minutes, has focal features at any time, or recurs within a 24-hour period.[6]

Furthermore, patients were divided into four age groups: infant group (<1 year), preschool-age group (1–6 years), school-age group (7–12 years), and an adolescent group (13–18 years).

Variables including age, sex, type of seizure, associated symptoms, family history of seizure or epilepsy, developmental history, laboratory test results, neuroimaging examinations, EEG findings, duration of hospital stay, diagnosis, admission, and anticonvulsants given in the ED were compared between Group 1 and Group 2. These variables were also compared between patients with simple febrile seizures and those with complex febrile seizures and between patients in different age groups.

Additionally, abnormal results of investigations, including white blood count, C-reactive protein, serum electrolytes, blood sugar and CSF analysis were recorded based on a pediatric textbook.[10]

### 2.3. Statistical analysis

Data for categorical variables were analyzed using $\chi^2$ or Fisher's exact tests, as appropriate. Data for continuous variables were analyzed using Student's *t* test; *p* less than 0.05 was regarded as statistically significant. Distributions of variables were reported as percentages and mean±SD.

## 3. Results

### 3.1. Demographics, clinical presentations, laboratory tests, brain imaging studies, EEG, diagnosis and hospital courses in patients with a first attack of seizure disorder

During the 2-year study period, 319 patients (173 boys and 146 girls) presented to the ED with a first attack of seizure and were enrolled in the study. Of these 319 patients (mean age, 2.56±2.98 years), 218 (68.3%) children presented with fever and 101 (31.7%) children were non-febrile. In this study, 299 (93.7%) of the 319 children who presented with a first attack of seizure were younger than 6 years of age. Among them, 213 (71%) presented with fever and 86 (29%) were non-febrile. Among the 20 patients over the age of 6 years, seizures without fever occurred more frequently than seizures with fever ($p<0.001$).

GTC seizure was the most common seizure type in our retrospective study ($n=227$; 71.2%). In addition, GTC seizures occurred more commonly in patients who presented with fever than in those presenting without fever ($p<0.001$; Table 1). Family history of seizure-related disorders was noted in only 26 (8.2%) patients. Among the 319 studied patients, 9 patients had a history of developmental delay, with language development delay being the most common. Cough and rhinorrhea were more common in patients who presented with seizures and fever than in those who presented with seizures without fever ($p<0.05$). Stool rotavirus antigen tests were performed in 69 patients with watery diarrhea; however, positive findings were recorded in only 14 (20%) of the 69 children. There was no significant difference in positive stool rotavirus antigen tests between febrile and non-febrile patients. In addition, CSF analysis was performed in 60 patients, but only 6 patients had abnormal results (Table 2[10]). All of these six had GTC-type seizures. Further, abnormal physical and neurological examinations were found in four of these six children. There was no significant difference in abnormal CSF results between febrile and non-febrile patients.

Imaging studies of the head (CT or MRI) were performed in the ED in 61 children who presented with a first attack of seizure during the 2-year study period. Indications for imaging studies in these 61 patients included history of trauma, prolonged postictal period, partial seizure activity,

**Table 1** Demographic data of patients with a first attack of seizure disorder

| | No fever ($n=101$) | | Fever ($n=218$) | | Total ($n=319$) | | *p* |
|---|---|---|---|---|---|---|---|
| | *n* | % | *n* | % | *n* | % | |
| Sex | | | | | | | |
| Female | 54 | 53.5 | 92 | 42.2 | 146 | 45.8 | NS |
| Male | 47 | 46.5 | 126 | 57.8 | 173 | 54.2 | |
| Age (yr) | | | | | | | |
| <1 | 33 | 32.7 | 29 | 13.3 | 62 | 19.4 | <0.001* |
| 1–6 | 53 | 52.5 | 184 | 84.4 | 237 | 74.3 | |
| 7–12 | 7 | 6.9 | 3 | 1.4 | 10 | 3.1 | |
| 13–18 | 8 | 7.9 | 2 | 0.9 | 10 | 3.1 | |
| Type of seizure | | | | | | | |
| GTC | 55 | 54.5 | 172 | 78.9 | 227 | 71.2 | <0.001* |
| Generalized tonic | 4 | 4.0 | 8 | 3.7 | 12 | 3.8 | |
| Partial | 9 | 8.9 | 7 | 3.2 | 16 | 5.0 | |
| Status epilepticus | 0 | 0.0 | 1 | 0.5 | 1 | 0.3 | |
| Others | 33 | 32.6 | 30 | 13.8 | 63 | 19.7 | |
| Family history of seizure | 3 | 3.0 | 23 | 10.6 | 26 | 8.2 | 0.026* |
| Family history of epilepsy | 4 | 4.0 | 2 | 0.9 | 6 | 1.9 | NS |
| Developmental delay | 3 | 3.0 | 6 | 2.8 | 9 | 2.8 | NS |

*Statistically significant by Fisher's exact test. NS = Not significant; GTC = generalized tonic-clonic seizure.

**Table 2** Details of abnormal cerebrospinal fluid analysis in six children[10]

| No. | Age | Sex | Fever | Physical and neurologic examination | CSF results* and causes |
|---|---|---|---|---|---|
| 1 | 8 d | Male | No | Bulging of anterior fontanelle | Pleocytosis and elevated protein, asceptic meningitis |
| 2 | 2 mo | Female | No | Normal | Markedly elevated protein and RBC, traumatic LP |
| 3 | 3 mo | Male | Yes | Normal | Markedly elevated protein and RBC, traumatic LP |
| 4† | 5 mo | Male | No | Normal | Pleocytosis, asceptic meningitis |
| 5‡ | 5 yr 5 mo | Female | No | Consciousness disturbance | Pleocytosis, meningoencephalitis |
| 6 | 17 yr | Female | Yes | Meningeal sign (+) Consciousness disturbance | Pleocytosis, meningoencephalitis |

*CSF results are based on *Nelson Textbook of Pediatrics,* 10th edition (Reference 10); †patient no. 6 in Table 3; ‡patient no. 14 in Table 3. CSF=cerebrospinal fluid; RBC=red blood cells; LP=lumbar puncture.

signs of increased intracranial pressure, focal neurologic deficits, persistent headache and persistent alteration of consciousness level. Among these patients, 16 (26%) had abnormal findings (Figure 1). Abnormal results of physical and neurological examinations were found in 12 of these 16 children; consciousness disturbance was the most common abnormal finding (Table 3). Encephalitis was diagnosed based on MRI findings in three patients with seizures accompanied by fever. In addition, EEG was performed in a total of 212 of the 319 patients; among these children, abnormal EEG results were more common in patients with non-febrile seizures than in patients who presented seizures with fever (34% *vs*. 14%, $p=0.001$). After emergency management in the ED, all of the patients in this study were admitted to hospital for further management (general ward, 83%; ICU, 12%; pediatric observation unit, 5%). Febrile seizures (62.1%) were the most common etiology and were diagnosed in 90.8% of patients with seizures accompanied by fever. Acute symptomatic seizures were diagnosed in 20 patients. These 20 patients presented with etiologies including hypoglycemia ($n=1$), anoxic seizure ($n=1$), hyponatremia ($n=2$), subarachnoid hemorrhage ($n=1$), subdural hemorrhage ($n=3$), posttraumatic head injury without intracranial hemorrhage ($n=3$), hydrocephalus ($n=1$), shaking baby ($n=1$), asceptic meningitis ($n=2$), meningoencephalitis ($n=2$), and encephalitis ($n=3$).

The investigations performed are shown in Table 4. The most common abnormalities detected were mildly raised serum glucose level and mildly depressed plasma sodium, which were probably a result, rather than the cause, of the fever or seizure. Severe hypoglycemia was noted in only one patient (blood sugar, .89 mmol/L) due to accidental ingestion of an oral anti-diabetic agent, and two infants suffered from seizure attacks due to severe hyponatremia (serum sodium, 112 mmol/L caused by water intoxication; 124 mmol/L caused by severe acute gastroenteritis, respectively). To our knowledge, fever, elevated white blood cell count and elevated C-reactive protein are indicators of potential severe bacterial infections. In our study, elevated white blood count was noted in 24% of 310 investigations and elevated C-reactive protein was noted in 34% of 262 investigations. We therefore suggest that white blood cell count and C-reactive protein should be considered in patients who present with first seizure.

Anticonvulsants were given to control seizures in 68 (21.3%) patients in the ED. Details of the emergency treatments given are shown in Table 5. Seizures subsided in 91% of these 68 patients after administering benzodiazepines (diazepam, midazolam and lorazepam); however, seizures persisted in six patients even after three doses of benzodiazepines had been administered. Seizures in these patients subsided only after the administration of phenytoin.

## 3.2. Clinical analysis in patients with febrile seizure

During the study period, febrile seizures were diagnosed in 199 (62.1%) patients, including 117 boys (58.5%) and 82 girls (41.2%). Of these 199 patients, 152 (76.4%) had a simple (febrile seizure) pattern and 47 (23.6%) had a complex (febrile seizure) pattern. We found that 84.9% of febrile seizures occurred in children aged 1–6 years ($p=0.001$). The underlying diagnoses in this group of children included: upper respiratory tract infections and systemic viral infections (45%), lower respiratory tract infections (16%), acute gastroenteritis (19%), urinary tract infections (8%) and enterovirus infections (12%).

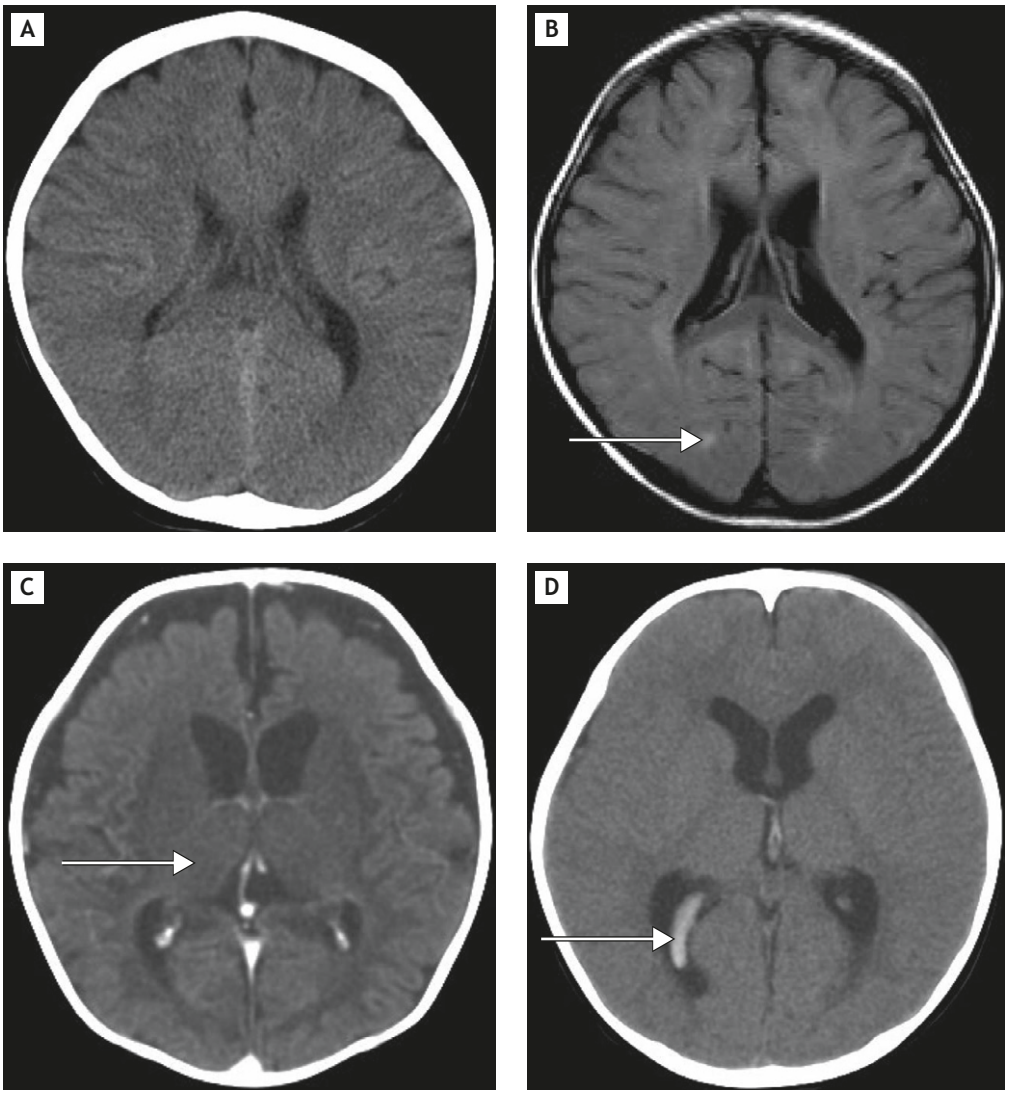


**Figure 1** Brain imaging studies showing a 1 year and 8-month-old girl (patient no. 13 in Table 3) with frequent seizure attacks who underwent brain computed tomography (CT). (A) No definite lesion seen. (B) Magnetic resonance imaging showed increased signal intensity on fluid attenuated inversion recovery in the gray matter of the cerebral hemispheres, especially in the region of the high parietal convexities, which could be correlated with ongoing encephalitis (white arrow). (C) A 2-month-old female infant (patient no. 9 in Table 3) who presented with cyanosis and seizure after choking on milk, showed low attenuation over bilateral basal ganglia, thalami and periventricular white matter zone on CT (white arrow). This could have been caused by hypoxic ischemic encephalopathy. (D) A 1 year and 6-month-old boy (patient no. 1 in Table 3) suffered a head injury in a traffic accident and brain CT showed intraventricular hemorrhage (white arrow) and mild subarachnoid hemorrhage.

Neuroimaging studies were performed in 19 patients and only 1 patient in the simple febrile seizure group (patient no. 12 in Table 3) produced non-specific findings. Abnormal EEG results were found in 8% of patients with a first attack of febrile seizures; however, there was no significant difference in abnormal EEG findings between patients with simple and those with complex (febrile seizure) patterns. Patients with complex (febrile seizure) pattern were admitted to the ICU more often than patients with simple (febrile seizure) pattern (23.4% *vs*. 2%, $p<0.001$). More patients with complex (febrile seizure) pattern received anticonvulsant treatment in the ED compared with those with simple (febrile seizure) pattern (42.6% *vs*. 12.5%, $p<0.001$). Almost all febrile seizures subsided after benzodiazepine administration in the ED; only three patients required phenytoin to control the seizure.

### 3.3. Analysis of first attack of seizure disorder in different age groups

The GTC type of seizure was more common in preschool-age children than in children in other age groups ($p<0.001$; Table 6). Furthermore, fever,

**Table 3** Details of abnormal brain imaging studies and seizure causes in 16 children

| No.* | Age | Sex | Physical and neurological examination | Cause | Brain CT or MRI results |
|---|---|---|---|---|---|
| 1 | 1 yr 6 mo | M | Consciousness disturbance | Head injury | IVH and SAH |
| 2 | 10 mo | F | Normal | Head injury | SDH, left side |
| 3 | 6 mo | M | Normal | Head injury | SDH, right side |
| 4 | 10 mo | M | Normal | Head injury | SDH, left side |
| 5 | 5 yr | F | Normal | Epilepsy | Focal low attenuation area right globus pallidus |
| 6 | 5 mo | M | Normal | Asceptic meningitis | Mild ventricular enlargement |
| 7 | 1 yr | M | Consciousness disturbance | Epilepsy | Low attenuation, subcortical area |
| 8 | 3 yr 10 mo | F | Hyperreflexia | Epilepsy (remote brain insult) | Focal brain tissue loss, left frontoparietal lobes |
| 9† | 2 mo | F | Coma, no light reflex of pupils | HIE | Low attenuation, bilateral basal ganglia, thalami periventricular white matter zone |
| 10 | 3 mo | M | Consciousness disturbance, retinal hemorrhage | Shaken baby syndrome | Diffuse low attenuation, cerebral hemispheres |
| 11 | 4 yr 9 mo | F | Hypertonia, hyperreflexia | Epilepsy, cerebral palsy | Communicating hydrocephalus |
| 12 | 2 yr 6 mo | F | Left arm and leg decreased muscle power | Febrile seizure | Small hypodensity lesion, right parietal lobe |
| 13 | 1 yr 8 mo | F | Consciousness disturbance | Encephalitis | Increased signal intensity on T2W1 and FLAIR of MRI, parietal area |
| 14 | 5 yr 5 mo | F | Consciousness disturbance | Meningoencephalitis | Increased signal intensity on T2W1 and FLAIR of MRI, left temporoparietal lobes |
| 15 | 2 yr | F | Consciousness disturbance | Encephalitis | Increased signal intensity on T2W1 and FLAIR of MRI, anterior parasagittal area |
| 16 | 2 yr 5 mo | F | Consciousness disturbance | Encephalitis | Increased signal intensity on T2W1 and FLAIR of MRI, right parasagittal and frontal area |

*Brain CT was carried out on patients no. 1–12, and brain MRI was carried out on patient no. 13–16; †death. CT=computed tomography; MRI=magnetic resonance imaging; M=male; IVH=intraventricular hemorrhage; SAH=subarachnoid hemorrhage; F=female; SDH=subdural hemorrhage; HIE=hypoxic ischemic encephalopathy; FLAIR=fluid attenuated inversion recovery.

vomiting and diarrhea were the most common presenting syndromes in this age group ($p<0.001$; $p=0.004$; $p=0.001$, respectively). In contrast, headache was more common in patients aged more than 6 years of age than in patients in other age groups ($p<0.001$).

CSF analysis results differed significantly between the four age groups ($p=0.019$). Abnormal CSF findings were more common in the infant group than in any other group. In addition, the etiologies of a first attack of seizure differed significantly between the four age groups ($p<0.001$). Febrile seizure, CNS infection, and rotavirus-related seizure were more common in children aged younger than 6 years than in the other age groups.

## 4. Discussion

Febrile seizures have been reported to be one of the most common causes of seizure attack in children.[11] We found that febrile seizures (62.1%) were the main etiology of a first attack of seizure in patients presenting at the ED, and upper respiratory tract infections and systemic viral infections (45%) were the main underlying diagnoses in this group of children. According to one report,[12] about 25–40% of children with febrile seizures have a family history of febrile seizures. In 2006, Chung et al[13] noted that family history of febrile seizure accounted for 17.5% of cases. In the current study, however, we found that only 10.5% of the children who presented to

**Table 4** Investigation of first seizures (all fits)

| Investigation | *n* (%) | Abnormal (%) | Normal range |
|---|---|---|---|
| Sodium | 283 (89) | 38 | 135–145 mmol/L |
| Calcium | 216 (68) | 14 | 2.2–2.5 mmol/L |
| WBC count* | 310 (97) | 24 | <1 yr: 5.0–19.5<br>1–3 yr: 6.0–17.5<br>4–7 yr: 5.5–15.5<br>8–18 yr: 4.5–11.5 |
| C-reactive protein | 262 (82) | 34 | <4.8 nmol/L |
| Blood sugar | 180 (56) | 48 | 3.3–5.6 mmol/L |
| Rotavirus antigen test | 69 (22) | 20 | |
| CSF analysis | 60 (19) | 10 | |
| Brain imaging† | 61 (19) | 26 | |

*WBC count is expressed in $\times 10^9$/L; †brain imaging includes computed tomography or magnetic resonance imaging. WBC=white blood cell; CSF=cerebrospinal fluid.

**Table 5** Emergency treatment of seizures ($n$=68)*

| Treatment given | Episodes† | Present‡ |
|---|---|---|
| Diazepam PR | 2 | 3 |
| Diazepam IV | 60 | 73 |
| Midazolam IV | 2 | 2 |
| Lorazepam IV | 1 | 1 |
| Phenytoin IV | 5 | 5 |
| Phenobarbital IM | 4 | 4 |
| Glucose IV | 4 | 5 |
| Endotracheal intubation | 9 | 9 |

*Approximately 21.3% of patients received anticonvulsant treatment; †this refers to no. of patients who received treatment; ‡this refers to the no. of treatment given in episodes. PR=per rectum; IV=intravenous; IM=intramuscular.

the ED with febrile seizures had a family history of febrile seizures. This suggests that emergency physicians should not depend on a family history of seizure disorders to explain the etiology when evaluating children with a first attack of seizure. A retrospective cohort study reported that diarrhea was a highly associated symptom in patients with seizures, and that rotavirus infection was an identified etiology.[14–18] In our study, rotavirus was confirmed by stool antigen analysis in 20% of patients who presented with seizures and diarrhea. We therefore suggest that a stool rotavirus antigen test may be considered if a patient presents with a first attack of seizure and diarrhea in the ED.

Most (94%) of our patients who presented to the ED with a first attack of seizure were under the age of 6 years old, and 71% of seizures coexisted with fever. In addition, the most common type of first attack of seizure in this age group was GTC. Seizure is an important neurologic complication of bacterial meningitis in patients, especially in young children, and is often associated with poor outcomes.[19,20] It is universally accepted that lumbar puncture is required in all children with meningeal signs. However, neurologic examinations are not easy to perform and are not reliable in very young children. The American Academy of Pediatrics recommends that a lumbar puncture should be considered in patients aged younger than 18 months who present with febrile seizures.[11] However, performing routine lumbar puncture in all children with a first attack of febrile seizures is still controversial. In the present study, lumbar puncture was performed in 37 of 218 patients who presented with seizures and fever; however, no definite organism was cultured or isolated. Of these 37 patients, encephalitis was diagnosed in three patients and meningoencephalitis was diagnosed in one child, and all of these four patients were found to have abnormal findings in physical or neurological examinations. Lumbar puncture should thus only be performed in the ED after a detailed examination of patients who present with a first attack of seizure and fever, rather than being performed routinely. It is also important for primary emergency physicians to rule out potential CNS infections in infants and children who present with a first attack of seizures without fever. In our study, CNS infection was diagnosed based on abnormal CSF findings in three non-febrile patients, including two infants.

Neuroimaging examinations of the brain can help emergency physicians to identify some causes of seizures, but it is not necessary to arrange these imaging studies on a routine basis.[8] In our study, 61 patients underwent head CT scan or brain MRI examinations and 16 patients had abnormal imaging findings. Fourteen of these 16 patients who showed abnormal brain imaging results could be predicted from their clinical histories and physical and neurological examinations. The other two patients showed only non-specific findings on brain CT. All of the patients with abnormal imaging findings

**Table 6** Analysis of patients with seizure disorders based on different age groups

| Age groups (yr) | | <1 | | 1–6 | | 7–12 | | 13–18 | | Total | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *n* | % | *n* | % | *n* | % | *n* | % | *n* | |
| Sex | Female | 30 | 48.4 | 110 | 46.4 | 5 | 50.0 | 1 | 10.0 | 146 | NS |
| | Male | 32 | 51.6 | 127 | 53.6 | 5 | 50.0 | 9 | 90.0 | 173 | |
| Seizure type | GTC | 28 | 45.2 | 192 | 81.0 | 4 | 40.0 | 3 | 30.0 | 227 | <0.001* |
| | Generalized tonic | 1 | 1.6 | 10 | 4.2 | 0 | 0.0 | 1 | 10.0 | 12 | |
| | Partial | 4 | 6.5 | 7 | 3.0 | 4 | 40.0 | 1 | 10.0 | 16 | |
| | Status epilepticus | 0 | 0.0 | 0 | 0.0 | 1 | 10.0 | 0 | 0.0 | 1 | |
| | Others | 29 | 46.8 | 28 | 11.8 | 1 | 10.0 | 5 | 50.0 | 63 | |
| Associated symptoms | | | | | | | | | | | |
| Fever | No | 33 | 53.2 | 53 | 22.4 | 7 | 70.0 | 8 | 80.0 | 101 | <0.001* |
| | Yes | 29 | 46.8 | 184 | 77.6 | 3 | 30.0 | 2 | 20.0 | 218 | |
| Cough | No | 44 | 71.0 | 117 | 49.4 | 7 | 70.0 | 8 | 80.0 | 176 | 0.004* |
| | Yes | 18 | 29.0 | 120 | 50.6 | 3 | 30.0 | 2 | 20.0 | 143 | |
| Rhinorrhea | No | 46 | 74.2 | 140 | 59.1 | 8 | 80.0 | 7 | 70.0 | 201 | NS |
| | Yes | 16 | 25.8 | 97 | 40.9 | 2 | 20.0 | 3 | 30.0 | 118 | |
| Headache | No | 62 | 100.0 | 237 | 100.0 | 7 | 70.0 | 8 | 80.0 | 314 | <0.001* |
| | Yes | 0 | 0.0 | 0 | 0.0 | 3 | 30.0 | 2 | 20.0 | 5 | |
| Vomiting | No | 58 | 93.5 | 171 | 72.2 | 9 | 90.0 | 9 | 90.0 | 247 | 0.001* |
| | Yes | 4 | 6.5 | 66 | 27.8 | 1 | 10.0 | 1 | 10.0 | 72 | |
| Diarrhea | No | 56 | 90.3 | 173 | 73.0 | 10 | 100.0 | 10 | 100.0 | 249 | 0.001* |
| | Yes | 6 | 9.7 | 64 | 27.0 | 0 | 0.0 | 0 | 0.0 | 70 | |
| Stool rotavirus antigen | Positive | 1 | 11.1 | 13 | 21.7 | 0 | 0.0 | 0 | 0.0 | 14 | NS |
| | Negative | 8 | 88.9 | 47 | 78.3 | 0 | 0.0 | 0 | 0.0 | 55 | |
| CSF analysis | Normal | 12 | 75.0 | 39 | 97.5 | 2 | 100.0 | 1 | 50.0 | 54 | 0.019* |
| | Abnormal | 4 | 25.0 | 1 | 2.5 | 0 | 0.0 | 1 | 50.0 | 6 | |
| Brain image | Normal | 5 | 45.5 | 29 | 74.4 | 7 | 100.0 | 4 | 100.0 | 45 | 0.045* |
| | Abnormal | 6 | 54.5 | 10 | 25.6 | 0 | 0.0 | 0 | 0.0 | 16 | |
| EEG | Normal | 29 | 69.0 | 125 | 82.8 | 6 | 60.0 | 5 | 55.6 | 165 | 0.026* |
| | Abnormal | 13 | 31.0 | 26 | 17.2 | 4 | 40.0 | 4 | 44.4 | 47 | |
| Diagnosis (etiologies) | Febrile seizure | 27 | 43.5 | 168 | 70.9 | 3 | 30.0 | 0 | 0.0 | 198 | <0.001* |
| | Epilepsy | 3 | 4.8 | 5 | 2.1 | 3 | 30.0 | 1 | 10.0 | 12 | |
| | CNS infection | 2 | 3.2 | 4 | 1.7 | 0 | 0.0 | 1 | 10.0 | 7 | |
| | Congenital anomaly | 0 | 0.0 | 1 | 0.4 | 0 | 0.0 | 0 | 0.0 | 1 | |
| | Metabolic disease | 0 | 0.0 | 3 | 1.3 | 0 | 0.0 | 0 | 0.0 | 3 | |
| | Trauma | 3 | 4.8 | 3 | 1.3 | 0 | 0.0 | 1 | 10.0 | 14 | |
| | Rotavirus related | 1 | 1.6 | 13 | 5.5 | 0 | 0.0 | 0 | 0.0 | 7 | |
| | Others | 26 | 41.9 | 40 | 16.9 | 4 | 40.0 | 7 | 70.0 | 77 | |
| Anticonvulsant in ED | No | 55 | 88.7 | 178 | 75.1 | 8 | 80.0 | 10 | 100.0 | 251 | 0.032* |
| | Yes | 7 | 11.3 | 59 | 24.9 | 2 | 20.0 | 0 | 0.0 | 68 | |

*Statistically significant by Fisher's exact test. NS=not significant; GTC=generalized tonic-clonic seizure; CSF=cerebrospinal fluid; EEG=electroencephalography; CNS=central nervous system; ED=emergency department.

were in the infant or the preschool-age groups. Among the patients who underwent a head CT scan, 11 patients had complex febrile seizures and none of them had any CT abnormalities. Similar results have been reported in other studies.[8] We therefore suggest that emergent brain imaging studies should not be routinely arranged for children who present to the ED with a first attack of seizure with no known history of head injury, normal physical and neurological examinations and no acute symptomatic cause other than fever.

It has been reported in previous studies[21,22] that routine examinations of glucose, electrolytes, calcium, blood urea nitrogen and creatinine were

not necessary in children whose consciousness levels had returned to baseline, those who had no risk factors for epilepsy, and those with normal physical examination findings. In our study, seizures caused by severe electrolyte imbalance or hypoglycemia were noted in only three patients. We suggest that electrolyte and blood sugar studies should be arranged based on detailed history-taking and thorough physical examinations, but should not be performed routinely.

Benzodiazepines are the anticonvulsant drugs of choice for the management of an acute seizure. However, if seizure activity persists despite repeated benzodiazepine dosing, phenytoin should be considered. If the seizure does not subside after administering phenytoin, then phenobarbital should be administered. Phenobarbital may have priority over other anticonvulsants for controlling neonatal seizures.[22] In our study, anticonvulsants were administered to 21.3% of patients who presented to the ED with a first attack of seizures, and intravenous diazepam was the main drug of choice. Anticonvulsants were given more frequently to patients in the preschool age group, and were more commonly used for patients with complex febrile seizures. None of the adolescents who presented with seizures required anticonvulsants in the ED. This may indicate that older children suffer from seizures for a shorter duration than younger children.

In conclusion, age, fever coexistence, seizure type, associated symptoms, physical and neurological examinations, and history of head injury may provide important information for primary emergency physicians when evaluating children with a first attack of seizures. Finally, we suggest that routine examination of brain imaging studies, electrolyte and blood sugar are unnecessary unless the patients present with an abnormal history, or abnormal results of physical or neurological examinations.

## References


1. Roth HL, Drislane FW. Seizures. *Neurol Clin* 1998;16:257–84.
2. Vining EP. Pediatric seizures. *Emerg Med Clin North Am* 1994;12:973–88.
3. Friedman MJ, Sharieff GQ. Seizures in children. *Pediatr Clin North Am* 2006;53:257–77.
4. Smith RA, Martland T, Lowry MF. Children with seizures presenting to accident and emergency. *J Accid Emerg Med* 1996;13:54–8.
5. Johnston C, King WD. Pediatric prehospital care in a southern regional emergency medical service system. *South Med J* 1988;81:1473–6.
6. Academy of Pediatrics. Provisional Committee on Quality Improvement, Subcommittee on Febrile Seizures. Practice parameter: the neurodiagnostic evaluation of the child with a first simple febrile seizure. *Pediatrics* 1996;97: 769–72.
7. Blom S, Heijbel J, Bergfors PG. Incidence of epilepsy in children: a follow-up study three years after the first seizure. *Epilepsia* 1978;19:343–50.
8. Maytal J, Krauss JM, Novak G, Nagelberg J, Patel M. The role of brain computed tomography in evaluating children with new onset of seizures in the emergency department. *Epilepsia* 2000;41:950–4.
9. Commission on Epidemiology and Prognosis, International League Against Epilepsy. Guideline for epidemiologic studies on epilepsy. *Epilepsia* 1993;34:592–6.
10. Kliegman RM, Behrman RE, Jenson HB, Stariton BF. *Nelson Textbook of Pediatrics*, 18th ed. Philadelphia: Saunders, 2007:2513, 2944–8.
11. Leung AKC, Robson WLM. Febrile seizures. *J Pediatr Health Care* 2007;21:250–5.
12. Wolf SM, Ochoa JG, Conway EE Jr. Seizure management in pediatric patients for the nineties. *Pediatr Ann* 1998;27: 653–64.
13. Chung B, Wat LCY, Wong V. Febrile seizures in southern Chinese children: incidence and recurrence. *Pediatr Neurol* 2006;34:121–6.
14. Zerr DM, Blume HK, Berg AT, et al. Nonfebrile illness seizures: a unique seizure category? *Epilepsia* 2005;46:952–5.
15. Lin SC, Hsu HY, Wang PJ, et al. Rotavirus gastroenteritis associated with afebrile seizure in childhood. *Acta Paediatr Sin* 1996;37:204–7.
16. Contino MF, Lebby T, Arcinue EL. Rotaviral gastrointestinal infection causing afebrile seizures in infancy and childhood. *Am J Emerg Med* 1994;12:94–5.
17. Wang YC, Hung KL. Benign seizures associated with mild diarrhea: clinical analysis of 20 cases. *Acta Paediatr Sin* 1993;34:451–7.
18. Narchi H. Benign afebrile cluster convulsions with gastroenteritis: an observational study. *BMC Pediatr* 2004;4:2.
19. Goetghebuer T, West TE, Wermenbol V, et al. Outcome of meningitis caused by *Streptococcus pneumoniae* and *Haemophilus influenzae* type b in children in The Gambia. *Trop Med Int Health* 2000;5:207–13.
20. Inoue S, Nakazawa T, Takahashi H, Kaneko K. Seizures in the acute phase of aseptic and bacterial meningitis. *No To Hattatsu* 1998;30:494–9. [In Japanese]
21. Gonzalez-del RJ. Febrile seizures. In: Barkin R, Caputo G, Jaffe D, et al, eds. *Pediatric Emergency Medicine*, 2nd ed. St. Louis: Mosby, 1997:1017–9.
22. Blumstein MD, Friedman MJ. Childhood seizures. *Emerg Med Clin North Am* 2007;25:1061–86.